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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER

OWENS, DOUGLAS W

ART UNIT PAPER NUMBER

2811

DATE MAILED: 10/03/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	<b>Application No.</b> 10/737,315	<b>Applicant(s)</b> RAAIJMAKERS ET AL.	
	<b>Examiner</b> Douglas W. Owens	<b>Art Unit</b> 2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 22 July 2005.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-29 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-29 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## DETAILED ACTION

### *Claim Rejections - 35 USC § 112*

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 29 – 31 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

3. Claim 29 recites the limitation "the first reactant species" in line 1. There is insufficient antecedent basis for this limitation in the claim.

The scope of claim 30 cannot be determined, since claim 30 has dependency from claim 30.

The scope of claim 31 cannot be determined, since claim 31 has dependency from claim 31.

### *Claim Rejections - 35 USC § 102*

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

5. Claims 1 – 4, 6 – 11 and 27 – 29 are rejected under 35 U.S.C. 102(e) as being anticipated by US Patent No. 6,203,613 to Gates et al.

Regarding claim 1, Gates et al. teach a dual damascene structure in an integrated circuit (Fig. 1B), comprising:

a trench (10) formed in an insulating layer (14);

at least one contact via (12) extending from a floor of the trench downwardly to a conductive element (16) below; and

a conductive lining layer (20) along surfaces of the trench and the contact via, the lining layer having a maximum thickness of less than about 100 Angstroms and a step coverage of greater than about 90% (Col. 5, lines 17 – 24).

Regarding claim 2, Gates et al. teach a structure, further comprising a metal integrally filling the lined trench and contact via (Col. 3, lines 26 – 39; Col. 10, lines 26 – 35 (inherent feature of dual damascene structure)).

Regarding claim 3, Gates et al. teach a structure, wherein the conductive lining layer comprises a metal nitride (Col. 10, lines 26 – 28).

Regarding claim 4, Gates et al. teach a structure, wherein the metal nitride layer directly contacts the insulating layer and the conductive element.

Regarding claim 6, Gates et al. teach a structure, wherein the metal nitride layer comprises titanium nitride (Col. 10, lines 46 and 47).

Regarding claim 7, Gates et al. teach a structure, wherein the metal nitride layer comprises tungsten nitride (Col. 10, lines 48 – 51).

Regarding claim 8, Gates et al. teach a structure, wherein the metal nitride layer comprises tantalum nitride (Col. 10, lines 48 – 51).

Regarding claim 9, Gates et al. teach a structure, wherein the lining layer has a thickness of between 20 and 100 Angstroms.

Regarding claim 10, Gates et al. teach a structure, wherein the lining layer has a step coverage of greater than 93%.

Regarding claim 11, Gates et al. teach a structure, wherein the lining layer has a step coverage greater than 97%.

Regarding claim 27, Gates et al. teach a structure, wherein the conductive lining layer is formed by atomic layer deposition.

Regarding claims 28 and 29, these are considered product-by-process limitations. "Even though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process." In re Thorpe, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

6. Claims 16, 17, 19, 20, 22 and 24 are rejected under 35 U.S.C. 102(e) as being anticipated by US Patent No. 6,037,258 to Liu et al.

Regarding claim 16, Liu et al. teach a metal structure (Fig. 5) in an integrated circuit, comprising:

- a metal runner (upper portion of 6) in an upper insulating layer (2);
- a metal contact (lower portion of 6) extending integrally from the metal runner through a lower insulating layer; and

a metal nitride layer (4) interposed between the upper insulating layer and the metal runner and interposed between the lower insulating layer and the metal contact, the metal nitride having a maximum thickness of no more than about 200 Angstroms on any surface.

Regarding claim 17, Lu et al. teach a structure, wherein the lining layer has a thickness of between 20 and 100 Angstroms.

Regarding claim 19, Liu et al. teach a metal structure, wherein the metal runner and the metal contact comprise the same metal.

Regarding claim 20, Liu et al. teach a metal structure, wherein the metal runner and the metal contact is copper (Col. 4, lines 66 – 67).

Regarding claim 22, Liu et al. teach a metal structure, further comprising a seed layer (5a,5b) interposed between the metal nitride layer and the metal runner and the metal contact.

Regarding claim 24, Liu et al. teach a metal structure, wherein the seed layer comprises copper.

### ***Claim Rejections - 35 USC § 103***

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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8. Claims 12 – 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al. as applied to claim 1 above, and further in view of US Patent No. 6,627,539 to Zhao et al.

Gates et al. do not teach a structure, wherein a width of the trench is less than 0.35 microns or 0.25 microns. Gates et al. do not teach a structure, wherein the contact via has a width of less than 0.35 microns or between 0.05 and 0.25 microns. Gates et al. is silent with respect the dimensions. Zhao et al. teach that the current trench in the art toward deep submicron technology involves feature sizes of less than 0.35 microns (Col. 1, lines 24 – 27), including lines with a width of 0.25 microns (Col. 1, lines 56 – 64), which lies within the claimed range. It would have been obvious to one of ordinary skill in the art to incorporated the teaching of Zhao et al. into the device taught by Gates et al., since it is desirable to use line widths that are known to be of sufficient width for the intended use as an interconnection line.

9. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Liu et al., as applied to claim 16 above, and further in view of Gates et al.

Liu et al. do not teach a thickness on the bottom and sidewall that is at least 93% of a maximum thickness of the metal nitride layer. Gates et al. teach a structure and method including ALD, wherein the maximum thickness on the bottom and sidewall is at least 93% of a maximum thickness of the metal nitride layer. It would have been obvious to one of ordinary skill in the art to incorporate the teaching of Gates et al. into the device taught by Liu et al., since it is desirable achieve fine thickness control of the layer.

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10. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Liu et al. as applied to claims 16 and 19 above, and further in view of US Patent Application Publication No. 2002/0127845 to Farrar.

Liu et al. do not teach a structure, wherein the metal runner and metal contact is aluminum. Farrar teaches that a variety of materials, including aluminum can be used in a dual damascene process (paragraph [0031]). It would have been obvious to one of ordinary skill in the art to incorporate the teaching of Farrar into the structure taught by Liu et al., since it is desirable to use reliable materials.

11. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Liu et al. as applied to claims 16 and 22 above, and further in view of US Patent Application Publication No. 2002/0006468 to Paranjpe et al.

Liu et al. do not teach a structure comprising a tungsten seed layer. Paranjpe et al. teach a structure including a tungsten seed layer used with copper (paragraph [0046]; claim 38). It would have been obvious to one of ordinary skill in the art to use tungsten for the seed layer, since it is a known material that is well suited for the intended use.

12. Claims 25 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu et al. as applied to claim 16 above, and further in view of US Patent No. 6,057,231 to Givens et al.

Liu et al. do not teach a structure having a depth to width ratio of greater than 2:1 or 8:1. Liu et al. is silent with respect to the aspect ratio. Givens et al. teach a dual damascene structure that can have an aspect ratio up to about 10:1 (Col. 9, lines 12 –



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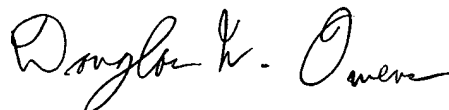
19). It would have been obvious to incorporate the teaching of Givens et al. into the device taught by Liu et al. since it is desirable to produce dual damascene devices with a high aspect ratio. It is further desirable to have an aspect ratio that is known to result in reliable devices.

***Response to Arguments***

13. Applicant's arguments filed July 22, 2005 have been fully considered but they are not persuasive.

Applicant argues that Liu et al. do not teach a liner layer having high step coverage and high uniformity. This is not a limitation recited in claim 16. The claim only requires that a maximum thickness of 200 Angstroms on any surface. Liu et al. sought to form a liner with a thickness in the range of 100 to 600 Angstroms, using plasma vapor deposition. The thickness of 100 to 600 Angstroms includes the claimed range. The layer may not have the step coverage of a layer formed using ALD, resulting in very thin sidewall layers. However, since Liu et al. was either not concerned about step coverage or unaware of poor step coverage arising from plasma vapor deposition, Liu et al. would not have compensated by depositing a layer that is much thicker than disclosed in lines 60 – 63 of column 3.

14. Applicant's arguments with respect to claims 1 – 15 and 27 – 29 have been considered but are moot in view of the new ground(s) of rejection.



Douglas W Owens  
Examiner  
Art Unit 2811